Engineer: Bruce Page	Date: 10-7-04	Raytheon **JPS Communications** 5800 Departure Drive, Raleigh, NC 27616			
Drawn: Bruce Page	Date: 10-7-04				
Approved: Chris Samios	Date: 10-20-04	Title: UNTERMINATED ACU-1000/ACU-T RADIO CABLE APPLICATION NOTES			
Issued/ Revised	Date: 4-12-05	Size: A	Dwg. #: **5961-271115-APP**	Rev: **B1**	Sheet: 1 Of 6

APPLIES TO:

Use of the un-terminated radio interface cable to develop an interface to the ACU-1000 or ACU-T.

This 2-foot cable can be used alone in a TRP-1000 radio tray, or in conjunction with the 13' long ACU-1000 extender cable P/N 5961-261002-00 to create a 15'ACU-1000 radio interface cable, or with the 13' ACU-T extender cable 5961-281013-00 to create a 15' ACU-T interface cable.

The unterminated cable assembly includes a component housing with a cable component PCB that allows all types of radios to be properly interfaced. Optimal interfaces may require DC blocking caps and/or attenuation networks. The PCB allows these components to be installed in a consistent and reliable manner. Without the housing the components would have to be spliced onto the wires and either left hanging in the splice or crammed into a connector housing, increasing the potential for shorts or eventual open circuits.

DC Blocking capacitors are pre-installed in the component housing. This allows the quick creation of an interface cable in the field, the communications tech need not worry about whether DC blocking is needed, or where and how to procure or install the capacitors.

RADIO MODIFICATIONS:

The following radio signals must be accessible; if not, modifications to the radio may be required. The modifications may be in the form of internal jumper changes and/or radio programming changes.

RX audio output from the radio to the ACU-1000: Line level output or speaker output

TX Audio input to the radio from the ACU-1000: Line level input or microphone input

PTT input to the radio from the ACU-1000

If the radio has a COR (unsquelch indication) output available, it should be included in the radio interface cable. If the COR signal is not present, the interface will work with the ACU-1000 in the VOX or VMR mode; however, use of the COR signal to give an exact indication of the radio's squelch/unsquelch condition is optimal.

One good design method is to create an interface cable that plugs into a radio's accessory connector or splices in the radio's accessory cable. If an accessory connector exists or if there is an option to add an accessory cable this should first be researched using the Radio Service Manual. When interfacing portable radios the speaker/microphone accessory will likely be needed to gain access to the required signals, with its cable spliced into the unterminated radio cable.

RADIO PROGRAMMING:

Radio programming changes are often required to enable necessary signals such as external PTT, external audio input, or external speaker output. Also be sure to investigate whether the radio being interfaced provides the output that changes state when the radio becomes unsquelched (it may be labeled COR, COS, or SQL). This output, if provided, may or may not be a programmable feature. This will need to be determined using the radio's Programming Manual and/or Service Manual. If this signal is available it should be enabled and connected to the interface cable's COR lead.

A common programmable item of many mobile radios, "HUB PL Defeat" controls a radio function whereby the insertion and removal of the radio microphone from its cradle (commonly called "Off Hook") enables and disables PL and DPL tone squelching. The intent is to allow the user to hear all traffic only when the microphone is out of the cradle, and have the RX audio gated by the PL and DPL tones when the mic is in the cradle. Since the microphone is not used with a radio cabled to the ACU-1000, this feature should be disabled.

Mobile radios should normally be programmed for low transmit power when cabled to an ACU-1000 as part of an interoperability system.

RADIO CONTROLS:

The use of speaker output may require the adjustment of the radio's volume control to supply the proper receive audio to the associated DSP Module. Adjust the Volume Control until the yellow "SIGNAL" indicator on the associated DSP Module flashes with receive audio peaks. If line level audio is available it should be used rather than speaker audio, as line level audio is usually not affected by inadvertent volume control setting adjustments. When the audio level is dependant on the volume potentiometer, it's useful to select a repeatable setting (such as at 12 o'clock) and then modify the DSP Module's RX level setting so that this repeatable setting provides the correct input level. This will allow quick re-adjustment of the radio's volume pot setting if it is inadvertently changed.

CABLE CONNECTIONS:

The Component PCB is connected via a short length of cable to the CPC Female 9 PIN connector (on the side of the PCB labeled TO ACU-1000), and on the other end to the unterminated wires that are used to interface the radio. These wires are associated with the CPC connector pin numbers and color codes as described in this table:

Unterminated Cable Pin-Out Descriptions

Name	Color	CPC Pin	Signal Description
SHLD	Drain wire with 1/8" heat shrink	PIN 1	Cable Shield
AUX	Brown	PIN 2	Auxiliary – No current use
ANA	Orange	PIN 4	Analog Ground
COR	Blue	PIN 7	Unsquelched indication from the radio
PTT	Green	PIN 6	PTT input to the radio
TXA	Violet	PIN 8	Transmit audio input to radio. Use as half of balanced audio pair or for single ended.
TXB	Red	PIN 3	Transmit audio input to radio. Use as half of balanced audio pair; ground for single ended.
RXA	Yellow	PIN 5	Receive audio output from radio. Use as half of balanced audio pair or for single-ended.
RXB	White	PIN 9	Receive audio output from radio. Use as half of balanced audio pair; ground for single-ended.
GND	Black	PIN 1	Main ground pin

Use the cable component PCB schematic (provided on subsequent page) to identify and configure the proper circuit to optimally interface the ACU-1000 to the radio as explained below. The unterminated cable is shipped with capacitors installed at positions C1 and C2 to provide DC blocking of both TX and RX audio, and with Jumper JU2 installed to allow straight-through wiring. Attenuation networks may be needed for optimal operation but are not installed, as they cannot be pre-determined.

DC Blocking

As previously mentioned, if DC blocking is required but not present, the effect can range from diminished performance to radio damage, while if DC blocking is present but not required, no change in performance will be seen. Therefore DC blocking capacitors are included in the unterminated cable for reliability and ease of in-the-field creation of radio interface cables.

Capacitor C1 blocks the interface from shorting any DC voltage on the radio's TX audio input. Connecting jumper JU1 can short out this capacitor, but this should not be necessary as the value of C1 (22uF) is chosen to not affect audio frequencies. Similarly capacitor C2 blocks DC on the radio's RX audio output (RXA) and can be shorted by connecting jumper JU4.

Balanced or Unbalanced (Single-Ended) Audio

Audio may be balanced (requiring a pair of wires) or single-ended (requiring only one wire). The use of balanced audio is preferred due to improved noise immunity (it provides "common-mode rejection").

Accessory Harness / Accessory Connector

The interface cable connections are usually interfaced to the radio by either an accessory harness (connected either internally or to a accessory connector) or to the microphone connector & speaker output connector. Use of the accessory connector is preferred; the accessory cable is more likely to have a COR signal and line level audio signals.

PTT Connection

The PTT output of the ACU-1000 can usually be connected directly to the radio's PTT input. The ACU-1000 PTT output will pull the radio's PTT input low to activate the radio's transmit function. The ACU-1000 PTT output can handle radio PTT inputs in the range of 0 VDC to +60 VDC and can sink up to 50 mA when PTT is active. Negative voltages should not be applied to the PTT input.

TX Audio Connection

The TX audio output from the ACU-1000 to the radio is balanced audio, but the unit will also accept unbalanced (single-ended) audio. If the TX audio input of the radio is balanced, connect TXA to the radio TX audio port labeled "+" or "Hi" (as in "mic hi" or "audio input hi"), and TXB to the remaining TX audio port. If the radio simply has a pair of undifferentiated balanced TX input ports, hook TXA to one and TXB to the other; it shouldn't matter which. If the TX audio input of the radio is unbalanced (single-ended), connect the TXA port to the radio TX audio input, and ground TXB. This can be done easily by placing a jumper on the cable component PCB at JU5, or can be accomplished by shorting the TXB lead to the ANA (analog ground) lead. If the radio signal named, for example, "mic lo" or "TX audio lo", is connected directly to ground within the radio, connect this lead to TXB and ground TXB to ANA.

If the TX audio input is being interfaced via the mic input, some attenuation of the TX audio input level will probably be needed for optimal operation. Simply put, most microphone inputs need a lower level signal (typically –28 to –35 dBm) than the ACU-1000 provides. Low-level signals are more prone to pick up noise. Attenuation at the radio end of the cable lessens the potential for noise problems. The R4 position on the cable component PCB provides shunt attenuation. A good starting point for R4 is a 22-ohm ¼ watt resistor. If the proper TX audio input level can be set with a 22-ohm resistor, move on to the RX audio connection. If the highest DSP module TX audio level setting does not provide sufficient audio to the radio, drop the attenuation level by increasing the R4 value. If the lowest DSP module TX audio setting still provides a too-high volume (noted by distorted RX audio on a radio it transmits directly to), increase the attenuation by reducing the value of R4.

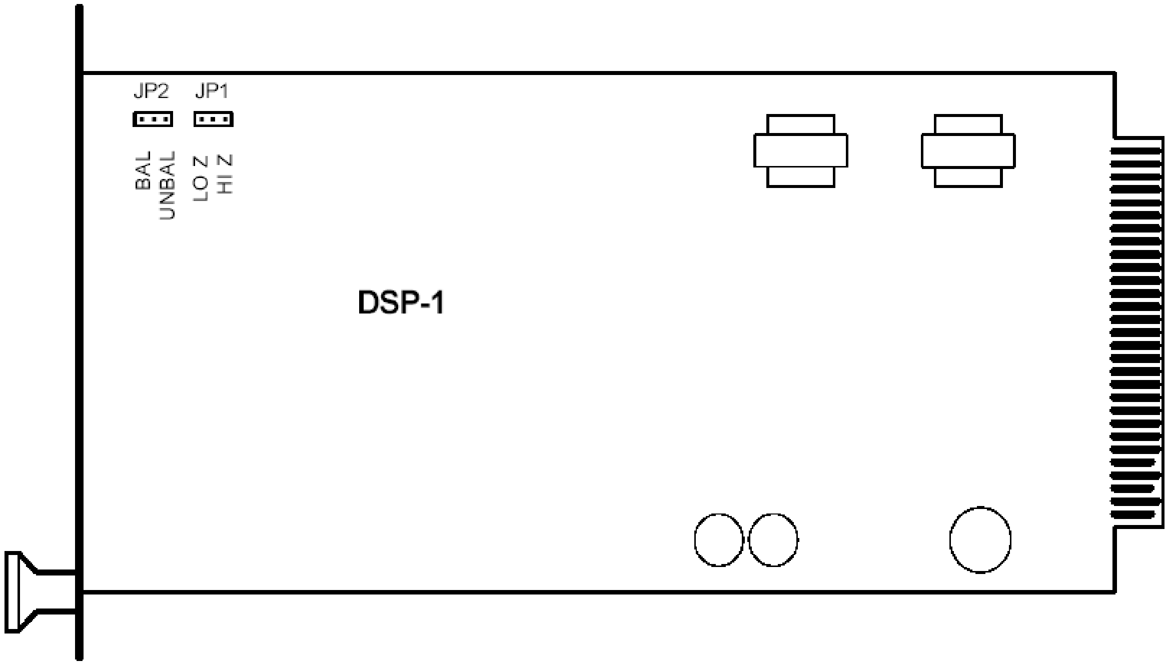
RX Audio Connection

If the radio RX audio is balanced, connect RXA to the radio RX audio port leveled "Hi" (as in "audio out hi" or "RX hi"), and RXB to the remaining RX audio port. If the RX audio output from the radio is unbalanced (single-ended) either from the accessory cable or if speaker audio is used, connect the radio RX audio output to RXA. For unbalance audio, connect RXB to ground. This can easily be done by placing a jumper on the cable component PCB at JU6, or the RXB lead may be shorted to the ANA (analog ground) lead.

DSP Module RX Audio Configuration Jumper Settings (See text below and sketches & table on next page): Note that the ACU-1000 receive audio input also has settings jumpers on the DSP module PCB. These settings adjust the module for either balanced or unbalanced, and set the impedance of the input. In the DSP-2 board Revisions A & B, the jumper that sets the input to the unbalanced mode also internally grounds the RXB lead. In the DSP-1 and DSP-2 Revisions C and higher, the jumper that sets the input to unbalanced does not ground this input. For this reason, it's best to ground this lead within the interface cable as described above. This creates a cable that will work with both DSP-1 and DSP-2 modules, and will function even if the balanced/unbalanced jumper is improperly set in the balanced position.

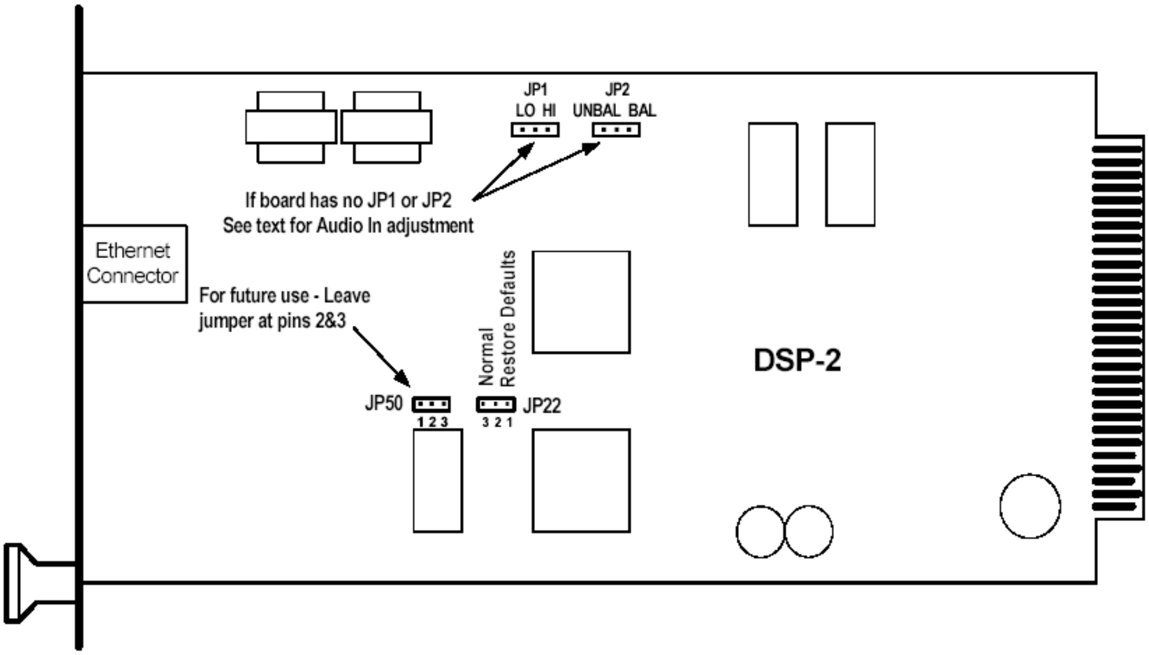
DSP-1 & DSP-2 Rev C or higher - Module Jumper Settings: Jumper JP2 sets the input to either balanced or unbalanced (single-ended). This jumper is in the upper left corner of the PCB and is marked "BAL & "UNBAL". JP1 is located alongside JP2 and sets the impedance of the RX input to either 600 ohms (marked LO on the PCB) or 47k ohms (marked HI on the PCB). The proper setting for balanced audio is usually 600 ohms (LO). An exception would be if another balanced 600-ohm device (such as a recorder) were also connected to the RX audio input. In this case, setting the input impedance to "HI" will prevent "double terminating" the balanced input. Note that a double termination does not harm any device or prevent operation. It does drop the RX level by an additional 3 dB. The proper termination for unbalanced audio is the HI impedance setting.

DSP-2 Rev A & Rev B - Module Jumper Settings: A single jumper J23 sets both the impedance and the balanced / unbalanced setting. See the module outline and table on the next page. The DSP-2 does not have an unbalanced high impedance setting. The DSP-2 also has a jumper (J15) that can jumper in DC coupling on the RX audio line. Since the unterminated cable already contains DC coupling capacitors, keep J15 set to AC coupling.



RX Audio Input Configuration Jumpers

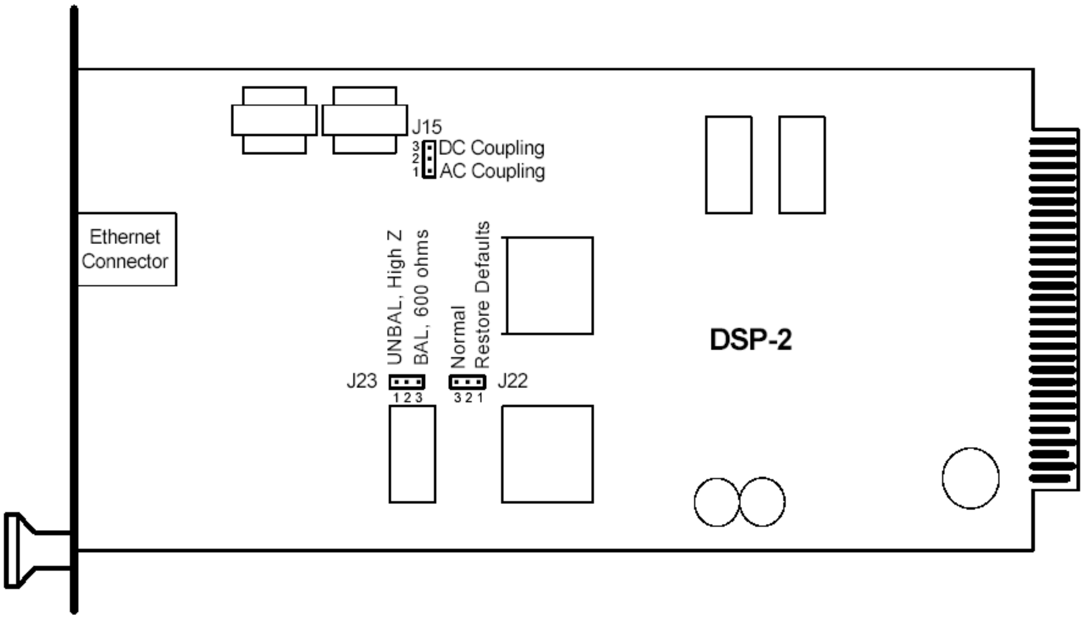
Bal/UnBal	Impedance	DSP-1 & DSP-2 Rev C or Higher		
		JP1	**JP2**	
Balanced	600 ohms	LO Z	BAL	
Balanced	High	HI Z	BAL	
Unbalanced	600 ohms	X	X	
Unbalanced	High	Don’t Care	UNBAL	



If board has no JP1 or JP2
See text for Audio In adjustment

For future use - Leave
jumper at pins 2&3

DSP-2 Rev C or Higher



DSP-2 Rev A and Rev B

The earlier revision of the DSP-2 shown above did not use the JP1 & JP2 and instead used J23 for the configuration this revision does not offer a Balanced, High Impedance setting. The table below shows the proper settings to achieve the desired RX Audio configurations for DSP-1 modules and both revisions of DSP-2 modules.

RX Audio Input Configuration Jumpers

Bal/UnBal	**Impedance**	**DSP-1 & DSP-2 Rev C or Higher**		**DSP-2 Rev A & B**
		JP1	**JP2**	**J23**
Balanced	600 ohms	LO Z	BAL	2-3
Balanced	High	HI Z	BAL	X
Unbalanced	600 ohms	X	X	X
Unbalanced	High	Don’t Care	UNBAL	1-2

COR Connection

The ACU-1000 DSP module can accept either an active high or an active low COR input from the radio. The factory default for COR is active low, which means that the signal goes low when the radio is unsquelched. If the signal instead is low while the radio is squelched, change to active high COR via the ACU Controller or the HSP-2 keypad.

NOTE: If the radio has a COR output, and this output is connected to the interface cable's COR lead, be sure to set the DSP Module squelch type to COR rather than the factory default, which is VOX. VOX operation works well, but the sure and immediate squelch condition indication provided by a COR input is preferable, so connect and use the COR input if one is available from the radio.

SHLD (Shield), GND (Ground), and ANA (Analog Ground) Connections

The cable shield is already connected to GND (pin 1 of molded CPC connector P1) and should not be grounded at the radio end of the cable or a ground loop may result. Connect the GND lead of the unterminated end of the cable to a power or digital ground lead at the radio. Connect ANA (Analog Ground) to a radio lead named "analog ground", "audio ground", or "mic lo". The radio may have only a single ground pin that corresponds with only one of these two ground leads. If so, connect only the appropriate single ground lead. In all cable designs, at least one of these two leads (GND and ANA) must be connected at the radio end of the cable.

NOTE: If the radio does not connect a speaker terminal directly to ground, do not ground that speaker lead in the cable or radio damage could result. In this case, connect the speaker audio using the RXA and RXB leads.

AUX (Auxiliary) Connection

This connection is reserved for custom/future uses and should be left unconnected.

Radio Interface Optimization

Use the DSP Module Radio Interface Setup Instructions and Flow Chart from the ACU Controller to complete the DSP setup and optimize performance. The list below shows the default settings. These are the initial settings as shipped from the factory. These settings can also be attained by applying the Default Template. See the ACU Controller for details.

DSP PROGRAMMING OPTIONS:

RX Level	3*	0dBm*
TX Level	6*	0dBm*
Squelch Type	VOX*	
COR Polarity	Active Low*	
High Frequency Equalizer	4*	Flat*
RX Audio Delay	2*	100 ms*
TX Audio Delay (Radio Type)	0*	No Delay* (See Notes)
Noise Reduction Value	0*	Off*
VOX/VMR Threshold	1*	Med1*
VOX/VMR Hang Time	3*	775 ms*
COR Inhibit After PTT	1*	100 ms*
All Others	As needed	

(* Indicates factory default value)

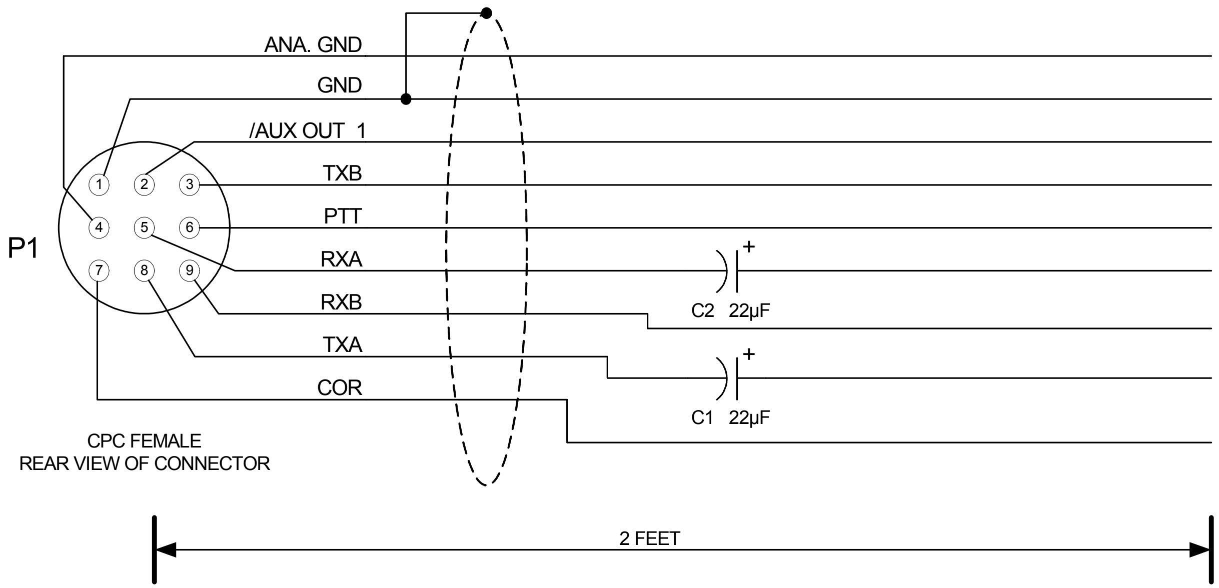
NOTES:

TX Audio Delay will be required for interfaces to trunked radio systems. The delay compensates for channel acquisition delays. Consult the ACU Controller DSP module setup instructions for further information.

Rev	ECO	Date
B		10-13-04

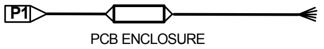
PURCHASED PART

USE MOLDED CABLE
(JPS P/N 5961-261003-00)



CPC FEMALE
REAR VIEW OF CONNECTOR

CABLE DETAIL



COMPONENT PCB
(JPS P/N 5961-271000)

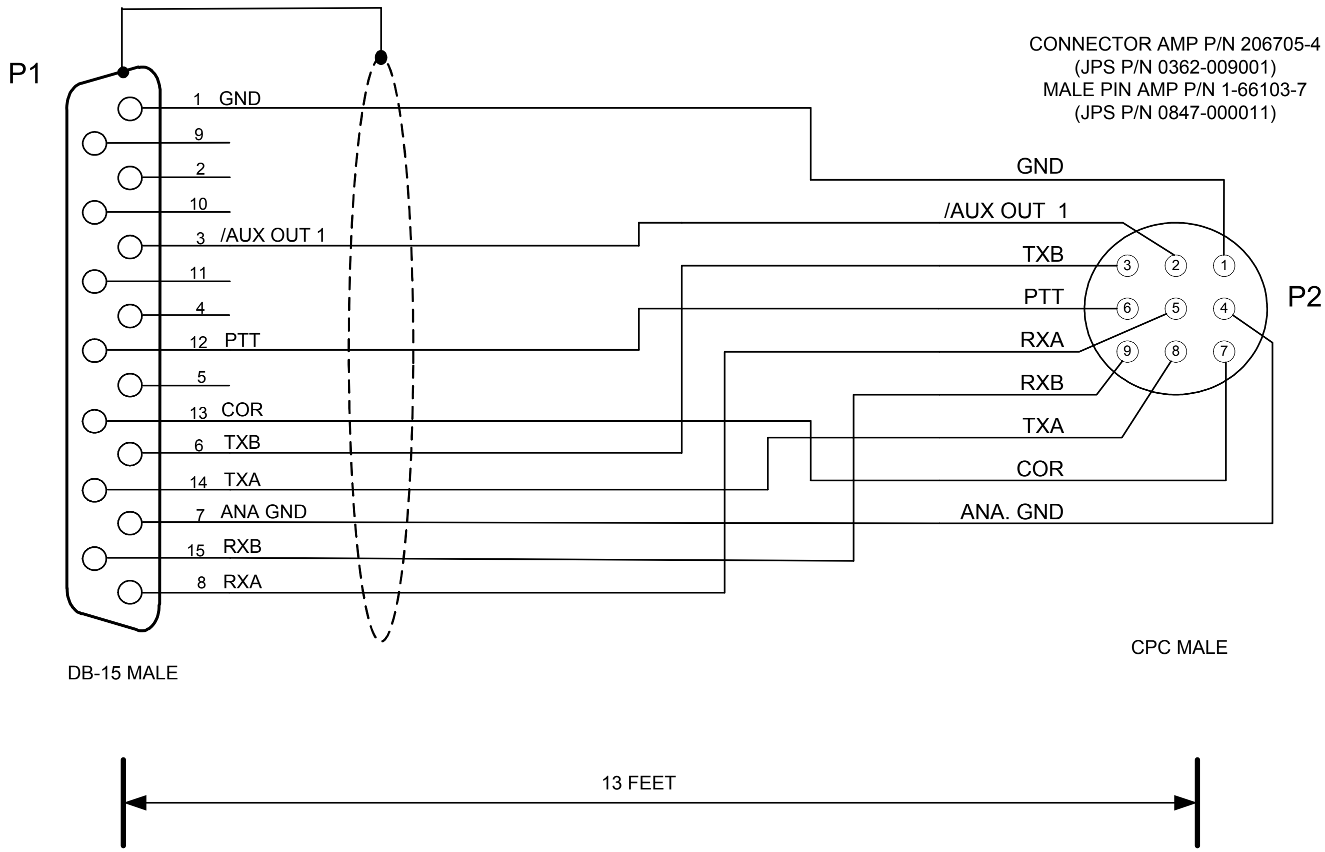
C1	JPS P/N 0321-220250
C2	JPS P/N 0321-220250
JU2	

NOTE: SHIELD DRAIN CONNECTED TO PIN 1 OF P1 ONLY.

Designed By: CTS	**Raytheon** **JPS Communications** Raleigh, NC USA		
Drawn By: RBP	Title CABLE, CPC TO UNTERMINATED		
Checked By: JAC	Size A	Document Number **5961-271115**	Rev B
	Issued Date October 15, 2004		Sheet 1 of 1

Rev	ECO	Date
A		

PURCHASED PART



CONNECTOR AMP P/N 206705-4
(JPS P/N 0362-009001)
MALE PIN AMP P/N 1-66103-7
(JPS P/N 0847-000011)

NOTES:
1) USE BELDEN 9934 SHIELDED CABLE.
2) CONNECT SHIELD DRAIN TO SHELL OF P1 ONLY.
3) CONNECTORS P1 AND P2 MUST BE MOLDED TO THE CABLE.
4) CABLE MUST BE LABELED WITH THE RAYTHEON/JPS P/N AND REV, VENDOR CODE AND DATE (MM/YY).

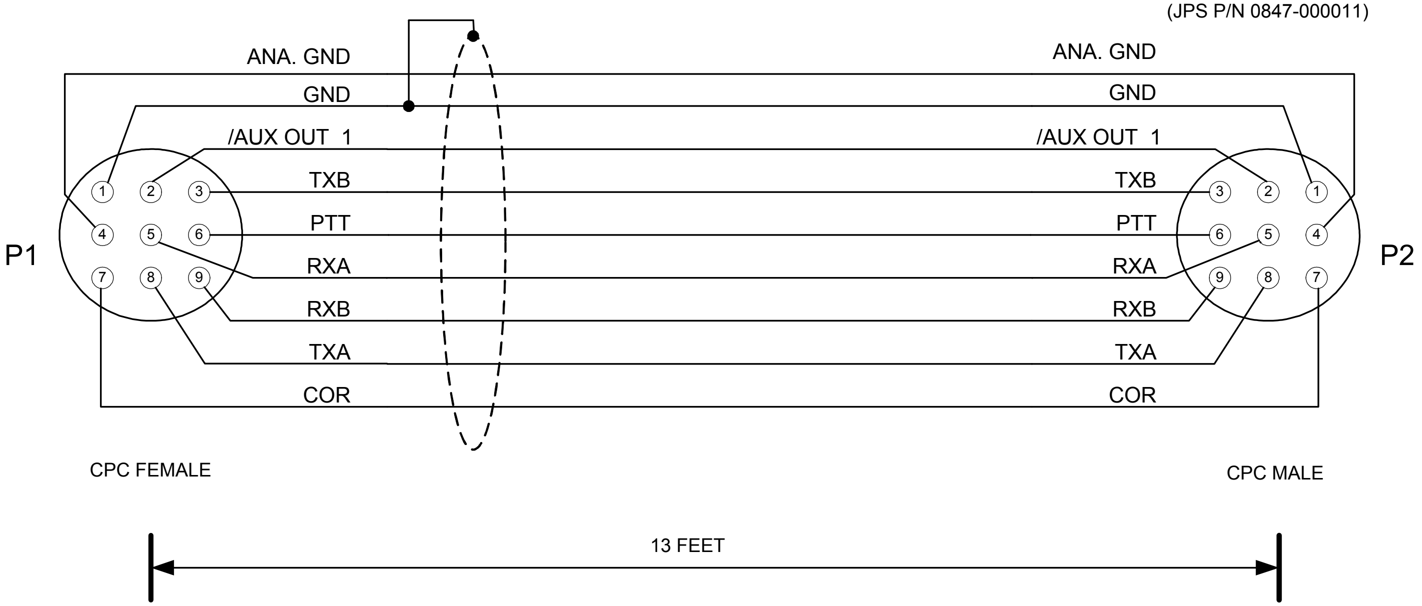
Designed By: JAC	**Raytheon** **JPS Communications**		
Drawn By: JAC	Title CABLE, ACU-1000 RADIO EXTENSION - 13 FT		
Checked By: RBP	Size A	Document Number **5961-261002-00**	Rev A
	Issued Date JANUARY 5, 2004		Sheet 1 of 1

Rev	ECO	Date
A		

PURCHASED PART

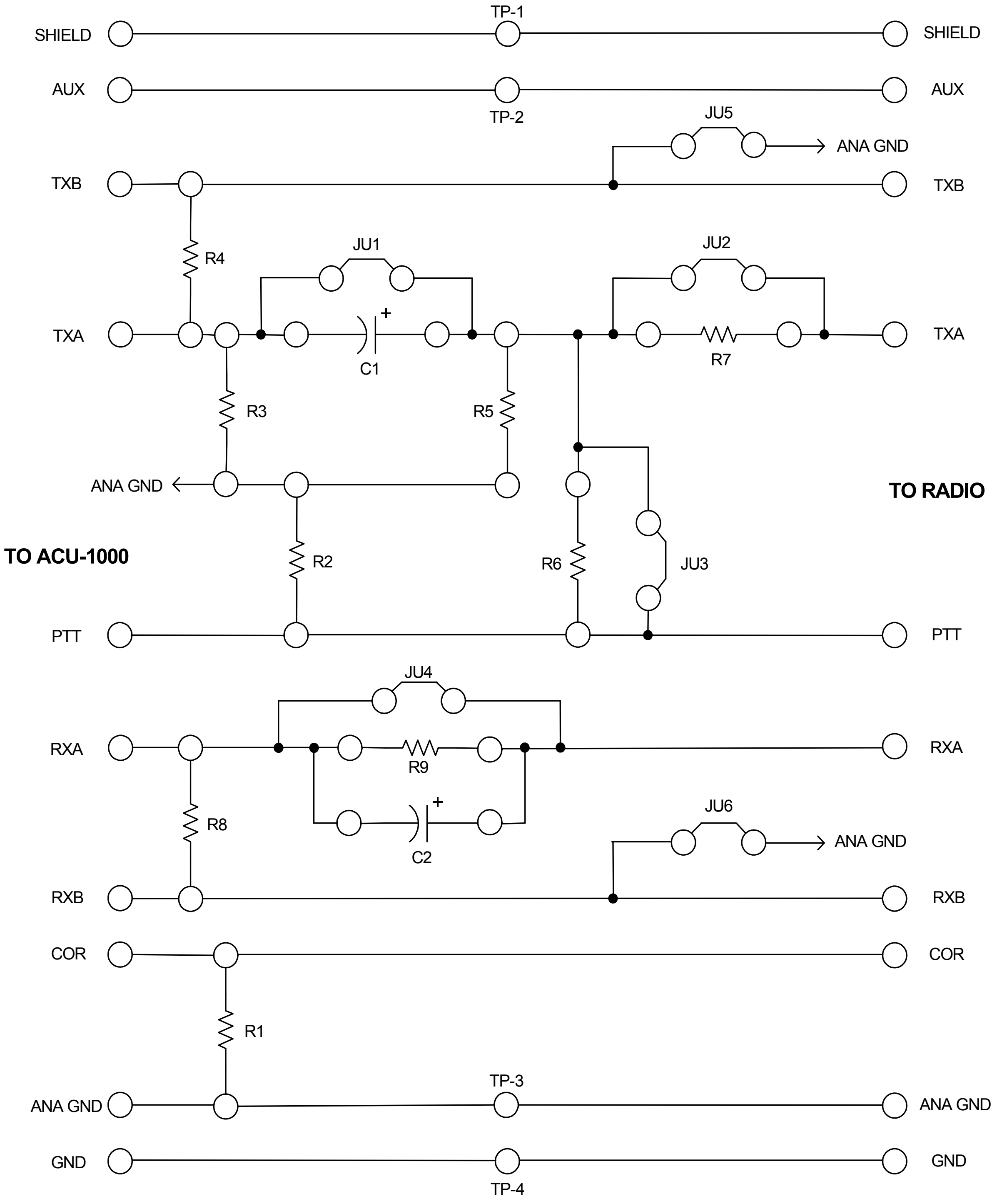
CONNECTOR AMP P/N 206708-1
(JPS P/N 0362-005003)
FEMALE PIN AMP P/N 1-66105-8
(JPS P/N 0362-005002)

CONNECTOR AMP P/N 206705-4
(JPS P/N 0362-009001)
MALE PIN AMP P/N 1-66103-7
(JPS P/N 0847-000011)



NOTES: 1) USE BELDEN 9934 SHIELDED CABLE.
2) CONNECT SHIELD DRAIN TO PIN 1 OF P1 ONLY.
3) CONNECTORS P1 AND P2 MUST BE MOLDED TO THE CABLE.
4) CABLE MUST BE LABELED WITH THE RAYTHEON/JPS P/N AND REV, VENDOR CODE AND DATE (MM/YY).

Designed By: JAC	**Raytheon JPS Communications** Raleigh, NC USA		
Drawn By: JAC	Title CABLE, ACU-T RADIO EXTENSION - 13 FT		
Checked By: RBP	Size A	Document Number **5961-281013-00**	Rev A
	Issued Date JANUARY 5, 2004		Sheet 1 of 1



Designed By: JAC	**Raytheon** **JPS Communications**		
Drawn By: JAC	Title CABLE COMPONENT PCB SCHEMATIC		
Checked By: RBP	Size A	Document Number **5961-271007**	Rev A
	Issued Date JANUARY 26, 2004		Sheet 1 of 1